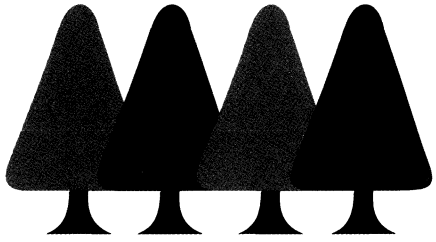
FOREST HEALTH



IN THE

NEW ENGLAND STATES & NEW YORK

January, 1998

Production, graphic design, and writing:

Jennifer Stoyenoff[1], John Witter, & Bruce Leutscher

University of Michigan, School of Natural Resources & Environment

Advisory committee:

Charles Barnett, Barbara Burns, Andrew Gillespie, David Heinzen, Manfred Mielke, Margaret Miller-Weeks, Florence Peterson, Frank Sapio, Brent Teillon, & Daniel Twardus

Data summaries provided by:

Douglas Allen, Robert Cooke, Dennis Lachance (North American Maple Project) & Manfred Mielke, Barbara O'Connell, Gretchen Smith (Forest Health Monitoring Program)

GIS images provided by:

Quinn Chavez, Susan Delost, & Tom Luther

FIA data provided by:

U.S. Department of Agriculture, Forest Service--Northeastern Forest Experiment Station and North Central Forest Experiment Station

In cooperation with:

U.S. Department of Agriculture, Forest Service & State Forestry Agencies

Stoyenoff, J., J. Witter, and B. Leutscher. 1998. **Forest Health in the New England States & New York.** University of Michigan, School of Natural Resources and Environment, Ann Arbor, MI. Unnumbered publication.

[1]Current address: The Dow Gardens, Midland, MI

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I. Our forest

Introduction

This publication provides basic information about forest health to land managers, extension personnel, students, educators, those involved in setting public policy, and the general public.

There are some basic, scientifically quantifiable variables that most people consider to be important when measuring the health of forests. These include tree mortality, tree growth, reproduction, injury to trees, condition of the tree crowns (the portion of the tree where the leaves are), and species composition of the forest area. However, forest health is not always easy to define. Determining whether a given forest is healthy also involves perceptions, judgements, and personal standards.

In terms of a number of variables that measure the condition of tree crowns, most tree species in the New England & New York Region score very well. This is an indication that the trees and forests in the region are generally healthy. However, some tree species and forest stands in certain areas are in poor condition. This is traceable to a number of stress factors. Various insects and diseases have stressed New England & New York forests to different extents. The most severe effects often occur when the impacts of these organisms are combined with adverse weather conditions or other stresses such as pollutants or forest fires.

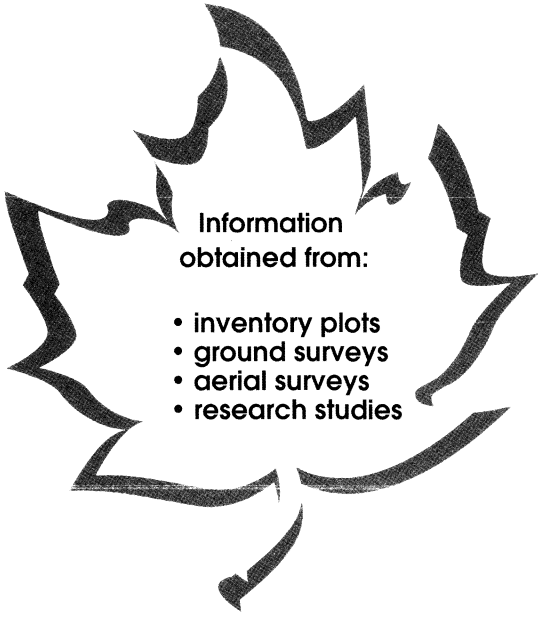
In this booklet we describe:

- Part I: characteristics of rural and urban forests in the New England & New York Region and how forest health is being studied,
- Part II: some recent key results (1990 through 1996) for the New England & New York Region from the National Forest Health Monitoring Program,
- Part III: factors that place stress on our forest and ways forest health has recently been affected by these factors.

On the back cover you will find a list of helpful phone numbers that will aid you in obtaining further information if you are interested.

How do we know about the health of the forest?

No single measurement can summarize forest health. Instead, we need to study many indicators which together serve as a reflection of existing conditions. Repeated monitoring of the forest over time allows us to identify changes and trends in forest conditions.

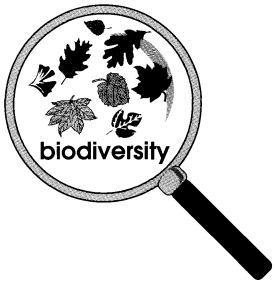


Information about forest health is obtained in a variety of ways. The USDA Forest Service conducts a program of Forest Inventory and Analysis, which provides information in each state on rates of tree growth and death, harvesting, and changes in forest area and tree species. The Forest Service and state agencies make regular ground and aerial surveys of forest pests and damage, both in permanent plots and in surrounding forest areas. Universities, private industry, and environmental groups cooperate with governmental agencies on a variety of forest research projects.

One major program aimed at understanding forest health is a joint federal/state program called the Forest Health Monitoring Program. This national program began in 1990 and is under the administration of the USDA Forest Service. It includes the active participation of state foresters, other federal and state agencies, and universities. The program goal is to monitor, assess, and report on the status, changes, and long-term trends in the health of our nation's forests.

The Forest Health Monitoring Program is composed of a network of permanent plots and other forest areas that are regularly visited to evaluate tree vigor, crown condition, and signs of tree damage. Additional data is recorded for a subset of the plots, including monitoring the effects of the common gaseous pollutant ozone on susceptible plants, noting presence and abundance of lichens (life forms that are a combination of algae and fungi, some of which are pollution sensitive), and recording information about the composition and structure of the plant community. Permanent plots have been established in 24 states. Long range plans are to eventually provide coverage of all forested areas in the United States. In the New England & New York Region, states currently participating in the Forest Health Monitoring Program are Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

A healthy forest gives us . . .



• Biodiversity: It is very important to maintain diversity of living organisms in our forest ecosystems. Diversity gives ecosystems stability and helps them deal with various stress factors. From a human perspective, having a variety of organisms present is aesthetically pleasing. In addition, many species may in one way or another benefit people and be of use to us. Some of these uses we already know about, but there also may be other undiscovered uses.

The best way to encourage high levels of biodiversity is to have a good mixture of habitats within our forests. This means maintaining a combination of various forest types, tree ages, and species compositions. Healthy forests usually have a mosaic of stand conditions present.

• Habitat and wildlife: Residents in the United States spend over $6 billion annually on trips where wildlife is the major attraction. Wildlife use different parts of the forest for food, shelter, and protection. Both living and dead trees are important for various wildlife species. Many species are quite specific in the kinds of conditions they need to thrive and therefore they are often associated only with a particular type or age of forest stand.

• Protection of soil: Forests help to prevent erosion, or the wearing away of soil through the action of wind and water. The canopy of leaves in the forest shields the ground from the hard pounding action of rain, slowing and softening its fall to the forest floor. Plants also contribute organic material to soil which helps soil absorb and hold water. This prevents the water from running off rapidly across the surface, carrying soil with it. Less visible than the movement of large soil particles but equally important, plants in the forest help to prevent the loss of important nutrients from the soil. They keep nutrients from being washed away across the surface of the land by rainfall. Also, by absorbing nutrients efficiently with their large spreading root systems they prevent nutrients from being transported by water deep down into the soil where they would be unavailable to the plants and animals that need them.

• Protection of water and air: Forests filter large amounts of water and air which flow through them. This filtering action helps trap some kinds of pollutants and remove them from continued circulation. Forests are important in increasing the amount and quality of drinking water available to people and also are important in providing us with oxygen.

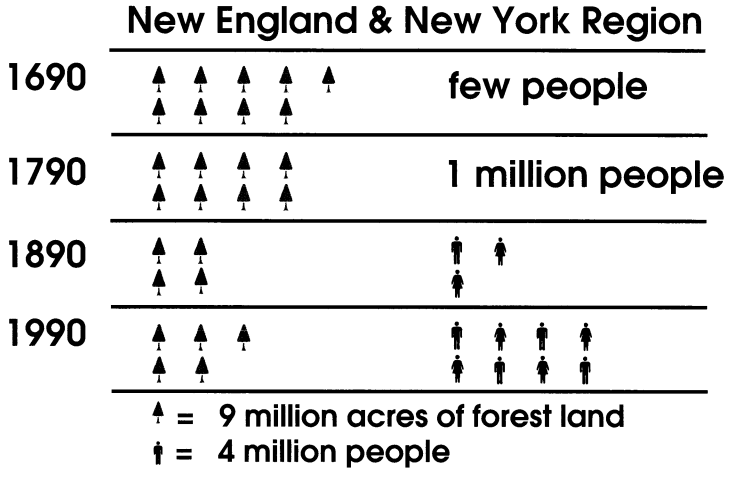
• Products: Forest trees provide us with lumber for building and wood that is used to make a variety of products such as furniture, containers, and paper. The annual value of wood products in Maine, New Hampshire, New York, and Vermont combined is at least $20 billion per year.

• Jobs: Forests are linked directly or indirectly to a large number of jobs. In Maine, New Hampshire, New York, and Vermont together, there are more than 230,000 people employed in forestry-related jobs.

• Recreation: People use forest areas for a great many recreational activities. Hiking, camping, hunting, fishing, skiing, bird watching, and photography are activities people like to do in forests. People value having forests available for these and other recreational uses and enjoy the shelter, shade, and spiritual comfort that the forest provides. In the United States, over 830 million visitors were recorded using national forest lands for various recreational activities in 1996.

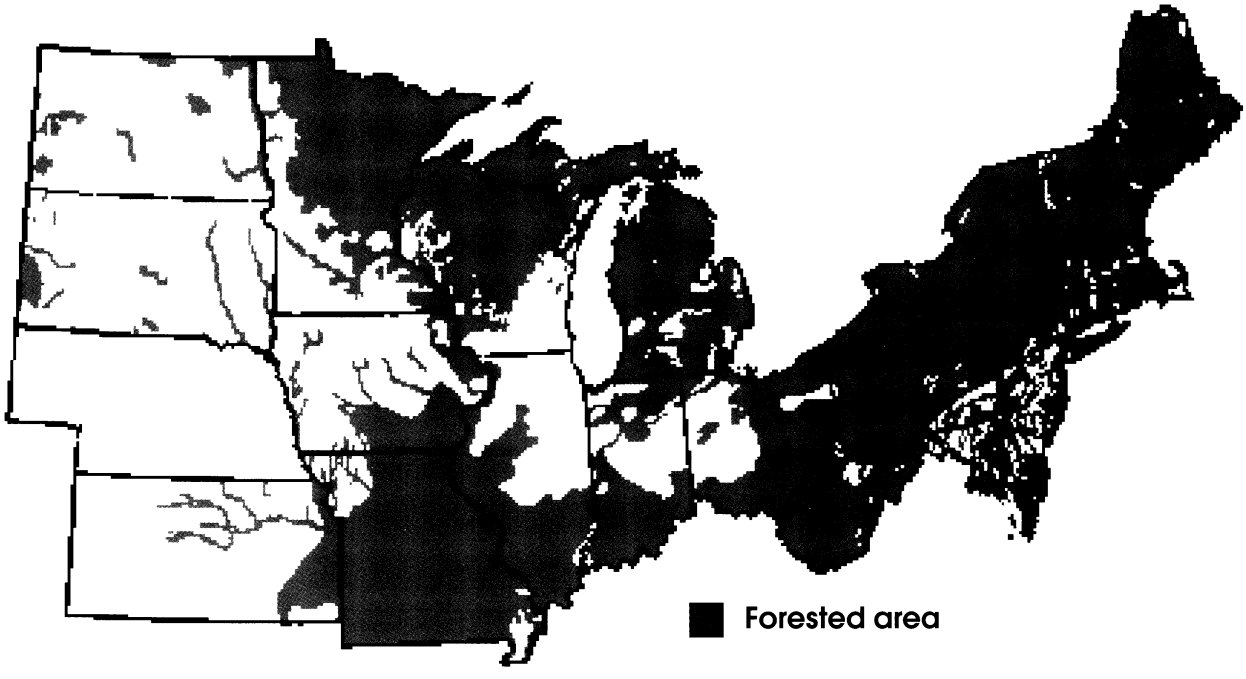
• Aesthetics: Forests enhance the beauty of the landscape, providing rich and varied scenery enjoyed by tourists as well as by those who live near the forests. Activities centering around appreciation of the aesthetic nature of forests, such as fall foliage viewing, are common in the New England & New York Region. These activities draw a great many visitors to forest areas annually. Forest-related tourism and recreation in Maine, New Hampshire, New York, and Vermont combined account for over 140,000 jobs and contribute over $7 billion annually to the area's economy.

How much forest is there?



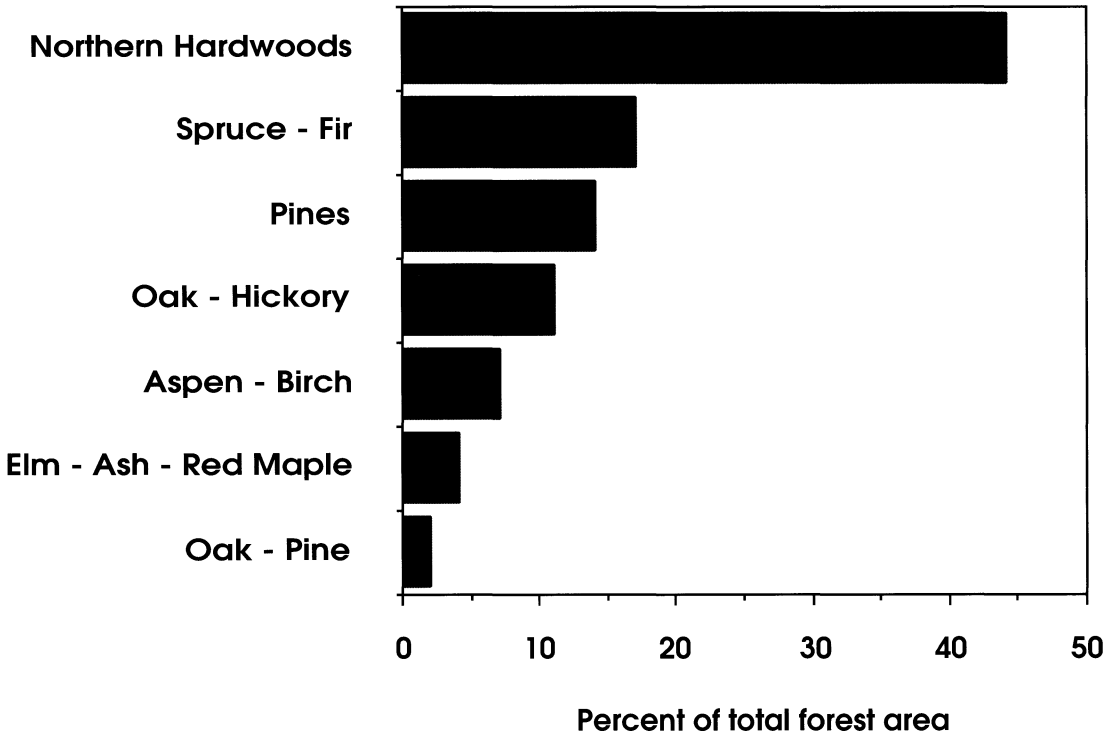
Human population levels in this region have increased sharply since the 1600s. From the 1600s through the 1800s, forest area decreased as land was cleared for agriculture. However, some farms were later abandoned and trees grew back. This has caused a slight increase in the amount of forest area during the last 100 years. In the future, human population levels will likely continue to increase, and the forest will be required to meet additional demands for resources as well as facing increasing levels of fragmentation as more land is used for housing and other purposes.

Where is the forest?

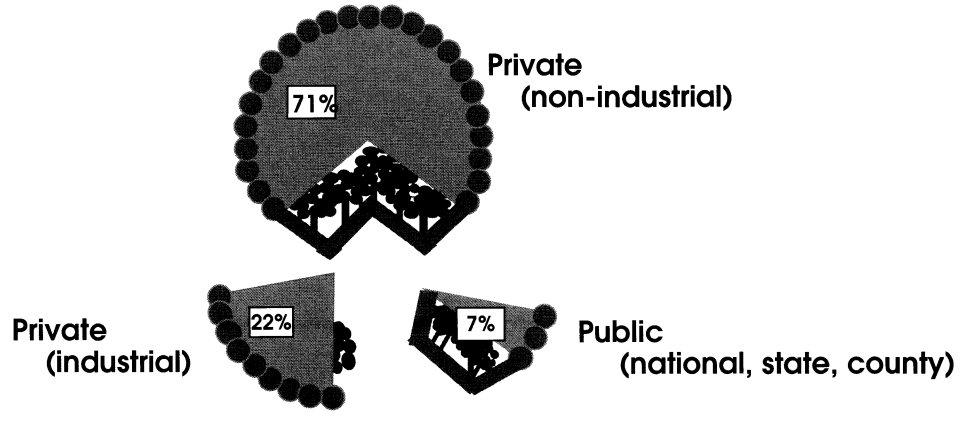


What kinds of trees make up the forest?

The forest can be divided according to the types of trees that dominate in various parts of the landscape. In the New England & New York Region, the most common forest types are:



Who owns the forest?



Because of the large amount of non-industrial private forest land, it is very important for private landowners to practice good stewardship in order to safe-guard forest health.

Trees in cities

When we compare urban trees and forest trees, we find that there are both differences and similarities. Urban trees:

- have higher average value as individuals than forest trees do.
  Total value of urban trees in the United States: $250 billion

- are fewer in number than forest trees.
  Size of urban forest in the United States: 93 million acres
  Number of urban trees in the United States: 610 million

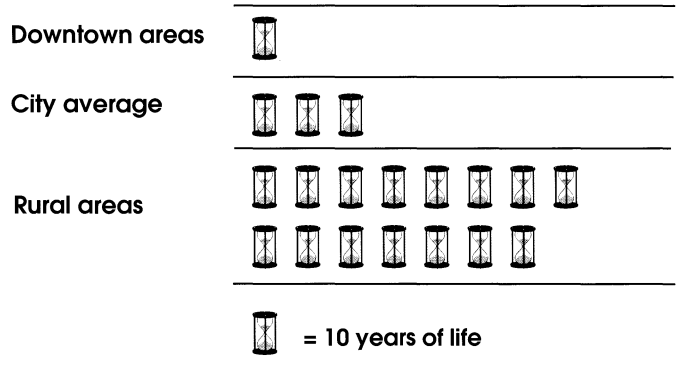
- provide shade for buildings and people.

- block noise.

- provide aesthetically pleasing scenery in urban areas.

- have shorter average life spans than forest trees.

  Average life expectancy of urban trees compared to rural trees in the United States:



Most frequently planted urban trees in the United States:

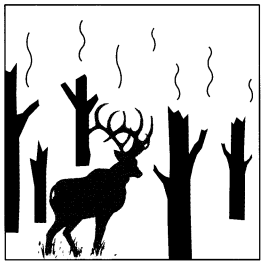
Norway maple
flowering crab apple
linden
green ash
honey locust
red maple

Common stresses on urban trees:

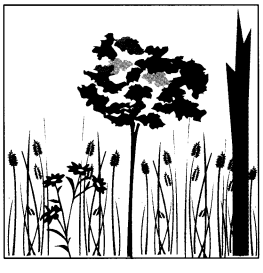
pollution
salt
nutrient deficiencies
soil compaction
drainage problems
construction
insects
diseases

Changes in the forest over time

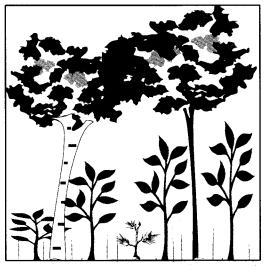
Forests are in a constant state of change. Disturbances in the forest--such as windstorms, fires, major pest attacks, land-use conversions, or logging operations--all are important factors that lead to changes in the forest. Yet even without such a disturbance, the composition of the forest will gradually change over time as the forest community matures. The particular changes that take place are influenced by the amount of light, nutrients, and water available to the plants. The gradual change in species composition and replacement of some forest species with others over time or after a disturbance is called *succession.*



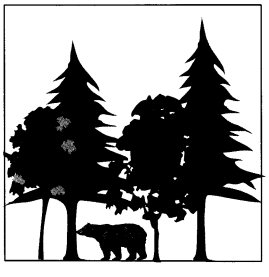
Disturbance may remove some or all of the existing vegetation, including eliminating a particular species.



Sun-loving, fast growing plants such as grasses, wildflowers, and trees like aspens and white birches are the first plants to establish in the disturbed area. These plants are called *early successional species* or *pioneer species.*



As the pioneer trees become larger and shade the area, other tree species begin to grow up in their shade. The particular plant community that will replace the early successional species will depend upon the amount of nutrients and water available to the plants. For example, if the early successional species at a site are aspen and white birch and the site is very wet, we would expect balsam fir and white spruce to be the next tree species at the site. If the site had only moderate moisture, we would expect red oak and red maple. If the site had less moisture, we would expect white pine.



Eventually, shade-tolerant species or species otherwise better suited for the current site conditions may take over as the short-lived pioneer species die out. The community will continue to undergo gradual changes in species composition, which will lead to a final, relatively stable community composed of species highly adapted to the growing conditions. These species are called *late successional species*, and this community sometimes is referred to as the *climax community*.

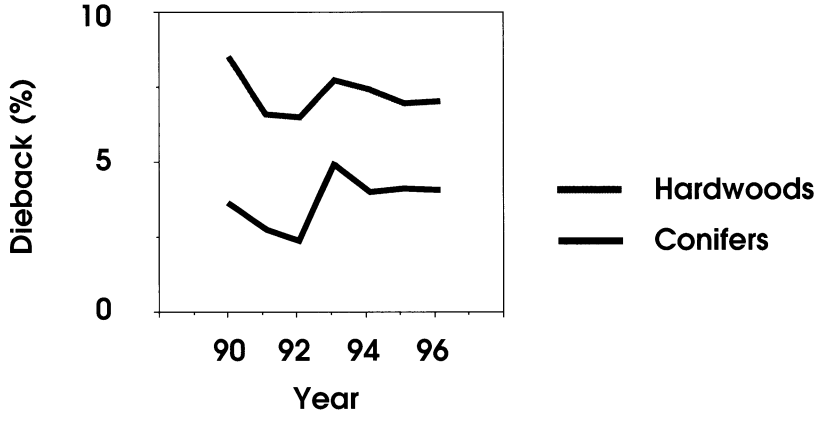
At any point along this successional sequence disturbance may occur, which will then set the forest back to an earlier stage in succession. Various harvesting techniques or pests could accelerate succession if they select against pioneer species.

II. What about tree health?

(All data summarized from Forest Health Monitoring plots in the New England & New York Region.)

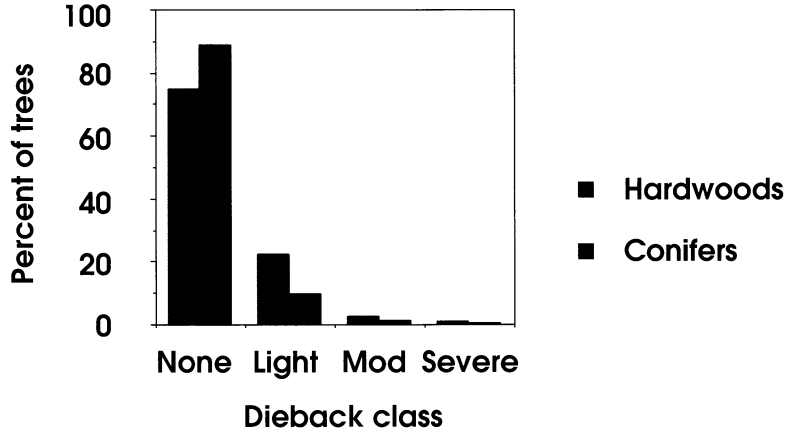
Crown dieback

One measure of tree health is *crown dieback*. This is one of the variables measured in the Forest Health Monitoring plots. Dieback is measured as the percent of branch tips in the crown that are dead. However, in making this measurement branch tips that are dead due to shading or competition are not included because they are dead due to the normal processes of tree growth. Therefore, the measurement only includes dead branch tips in the upper portion and outer edges of the live crown--these branch tips would generally be alive if the tree were not experiencing stress. Amount of dieback differs among tree species. Some species will normally show a small amount of dieback. While such small amounts of dieback are not considered to be a problem, larger amounts of dieback indicate that a tree is under extra stress. Trees with high dieback values have a reduced amount of leaf area for producing food. Dieback has varied among years and between hardwoods (e.g., maple, oak) and conifers (e.g., pine, fir):



Hardwood trees tend to have higher amounts of dieback than conifer trees. This is partly due to physiological differences between these two groups of trees. The energy needed to grow a completely new set of leaves each year and the additional effect that drought has on hardwood trees is partly responsible for the higher dieback rates.

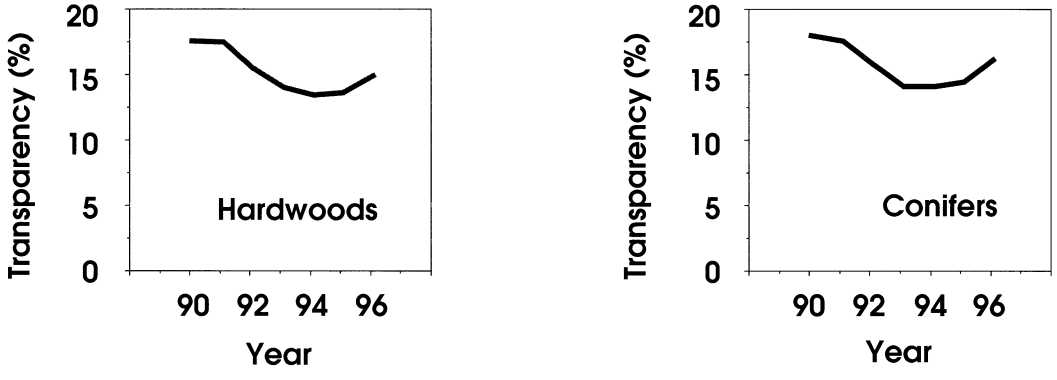
Dieback also can be described as none (0-5%), light (6-20%), moderate (21-50%), or severe (51-100%). In a detailed look at the data for 1996, we can see the percent of the trees that were in each of these classes:



Over 97% of all trees in 1996 were classified as having either no crown dieback or light crown dieback.

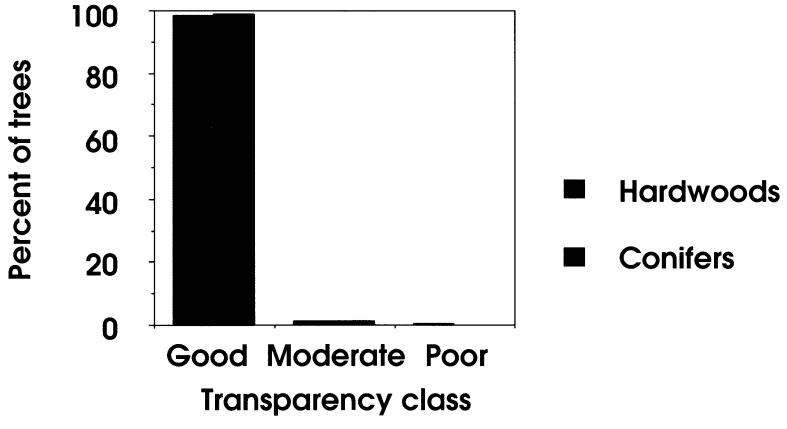
Foliage transparency

Foliage transparency also tells us about tree health. This variable measures the amount of light that shines through the live portion of a tree's crown as a percent of total light that would be visible if the light were unblocked. Light comes through the crown where leaves are missing, damaged, smaller, or less numerous than normal. Transparency values differ among tree species and are affected by the tree's shape and growing conditions. Higher transparency values than normal for a species indicate that the tree has less leaf area to catch sunlight for photosynthesis. High transparency values may result from insects feeding on tree leaves and damaging them, diseases causing leaves to fall or become damaged, or other stresses such as drought or frost that can affect a tree's leaves. Shown below are transparency values for hardwoods and conifers:



Transparency fluctuates from year to year as shown in the above graphs. This variation is natural and is influenced by a variety of factors including stress caused by drought and pest outbreaks. Transparency would have to change by more than 20% for the difference to be significant.

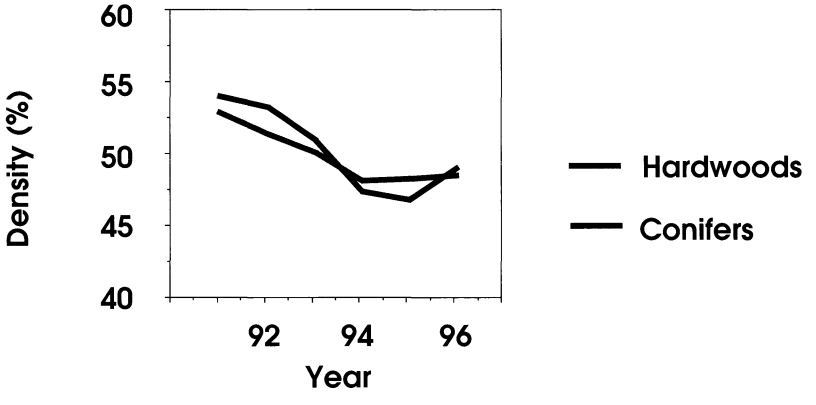
Transparency can be described as being good (0-30%), moderate (31-50%), or poor (51-100%). In a detailed look at the data for 1996, we can see the percent of the trees that were in each of these classes:



About 98% of the trees were classified as having good foliage transparency in 1996. No single tree species exhibited overall moderate or poor transparency values.

Crown density

Another way to measure tree health is *crown density.* Density tells us the amount of plant material, such as leaves, branches, and fruit, that block skylight from shining through the tree crown. It is measured as the percent of total light that is blocked by tree material. Unlike transparency, this measurement takes into account both the live and dead parts of the crown rather than just the live portion. Because density measurements consider all parts of the crown, density is not a perfect mirror image of transparency. Like transparency, density differs among tree species and is affected by the tree's shape and growing conditions. For transparency, high values indicate poorer tree condition. For density, however, high values indicate that the tree has a large amount of leaf material available for photosynthesis and has growing conditions that enable full and symmetrical growth. Low density values indicate poor amounts of foliage, a thin crown, or a missing section of crown and may result from stresses such as injury due to insects and diseases or other environmental factors such as drought, wind, competition, or soil compaction. Density fluctuates from year to year as shown in the graph below:



This variation in density is natural and is influenced by a variety of factors. One of the most important factors influencing the variation is drought. Pest outbreaks also can lead to density change. The minor fluctuations seen in the graph above appear to be associated with these types of stress events. Density would have to change by more than 20% for the difference to be significant.

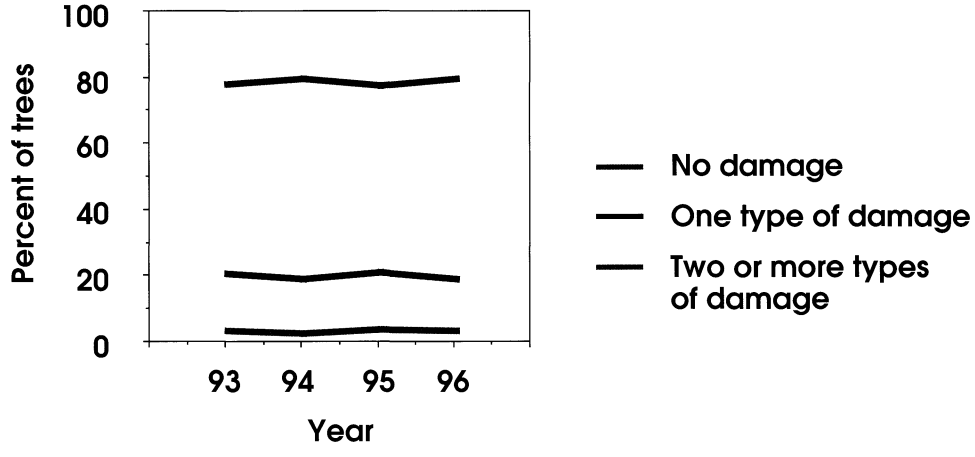
Density also can be described as being good (51-100%), moderate (21-50%), or poor (0-20%). In a detailed look at the data for 1996, we can see the percent of the trees that were in each of these classes:

Most trees are doing very well in terms of foliage density. Over 97% of all trees were classified as having good or moderate foliage density in 1996.

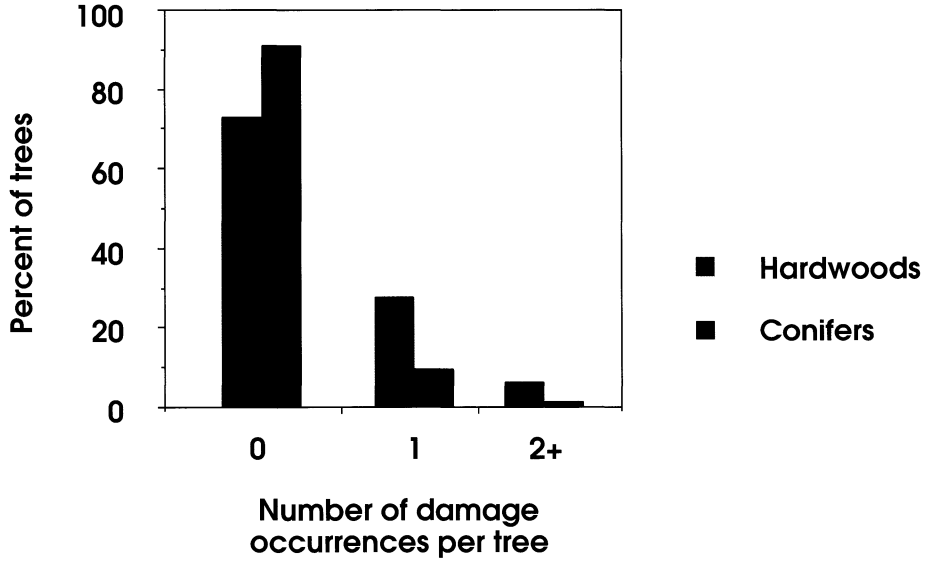
Damage to trees

Damage caused by diseases, insects, weather extremes, or other agents can have both positive and negative impacts on ecosystem health. A certain amount of damage is to be expected and is even desirable for the ecosystem in general. For example, holes in trees are used for shelter by wildlife and decaying wood harbors insects which are a major part of the food chain. However, sometimes the damage can be extreme, and it causes reductions in tree growth and increases in tree death.

In Forest Health Monitoring plots, information is collected on certain types of damage which may potentially kill trees. For each tree, type, location, and severity of damage is recorded. The purpose of this data is to provide baseline information on how much and what types of damage are present. This is information against which future trends may then be compared. The graph below shows amount of damage that trees have in the sample plots:



The majority of the trees in the sample plots have no visible signs of damage that threaten their long-term growth and survival. Of the 20% of trees with damage, decay is the most commonly observed type. Hardwood trees tend to have more damage than conifer trees, as indicated here in the 1996 data:



Ozone injury

Ozone is a gas formed both by natural processes and through human activities. Naturally formed ozone results from lightning during thunderstorms and by the action of sunlight on oxygen in the upper atmosphere. Human activities cause ozone formation because we burn fossil fuels in automobile engines and industrial enterprises. This burning process gives off hydrocarbons and nitrous oxides, which react with sunlight and lead to ozone formation near ground level.

Naturally formed ozone occurs mainly in the upper portions of the atmosphere. This ozone makes up the ozone layer, which shields us from harmful ultraviolet radiation. Ozone located in this layer is beneficial. On the other hand, ozone that is formed through human activities occurs in the lowest layer of the atmosphere. This ozone at the earth's surface can be damaging to plants and harmful to humans.

There is increasing concern about how ozone exposure is affecting the health of our forests. Ozone in the lower atmosphere is transported on air currents even to remote forest areas. Elevated concentrations of ozone in the eastern United States are common during the summer months when growing plants are most vulnerable to injury. Ozone is taken up by plant leaves during the process of photosynthesis. If conditions are suitable for rapid photosynthesis, such as presence of adequate moisture and warm temperatures, injury caused to the plant by high ozone levels may be especially great due to high ozone uptake.

Some plant species are especially sensitive to ozone and show clear signs of injury. They can be used as indicators of conditions that favor ozone injury to plants and are known as bioindicators. The most useful bioindicator species in the New England & New York Region include milkweed, black cherry, and blackberry. Bioindicator species frequently show visible injury such as discoloration or spotting on the upper surfaces of their leaves from June to September. This discoloration varies among species and ranges in color from red or purple to brown. The effects of ozone on sensitive plants are cumulative, with symptoms becoming more noticeable and more severe in late summer. At this time, the susceptible plants often drop their leaves prematurely. Growth loss also has been documented in sensitive varieties of white pine, aspen, black cherry, and other species. The stress that plants can experience from exposure to ozone also increases their susceptibility to pests and other stress factors.

The Forest Health Monitoring Program examines biomonitoring sites associated with nearby forested plots. These biomonitoring sites are easily accessible openings that contain bioindicator species. These sites are visited yearly during a 15 day period in early to mid-August to determine the distribution and severity of ozone injury. Records of injury give a meaningful picture of plant exposure to ozone occurring across the region and provide an indication of changes in air quality for the region.

The maps on the facing page show the distribution of biomonitoring sites in the New England & New York Region. Plants at 59%, 34%, and 39% of the sites in this region in 1994, 1995, and 1996, respectively, exhibited signs of ozone injury. As shown on the maps, sites with ozone injury are found in every state. This underscores the regional nature of ozone pollution. More sites with ozone injury and higher injury severity rankings for the injury occur in southern New England where air quality is worse than in more northern areas.

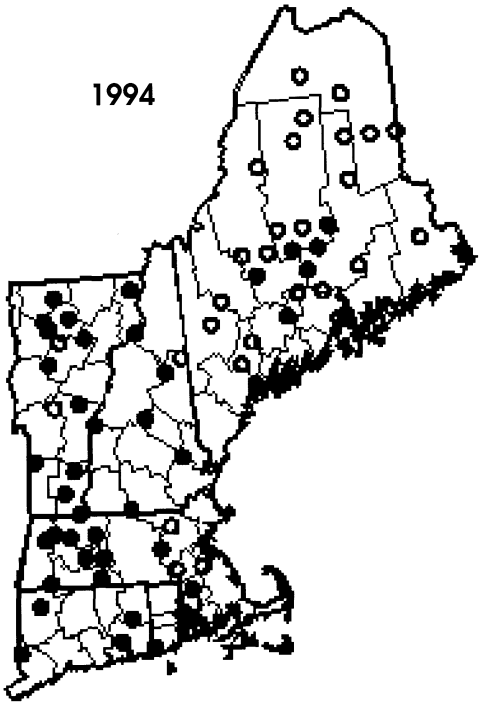
It is important to document fluctuations in the number and distribution of areas with ozone injury. Examining associations between ozone injury and forest conditions will provide answers to important questions about the long-term effects of ozone on forest health.

Forest Health Monitoring plots evaluated for ozone injury in 1994, 1995, and 1996.

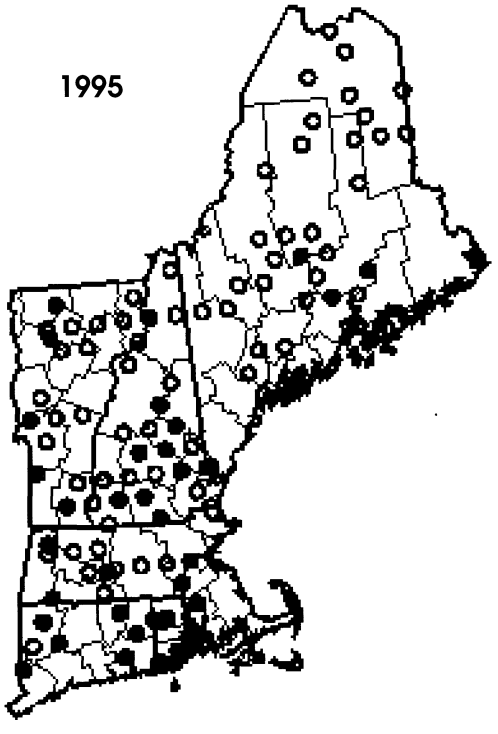
● Injury present

○ Injury not present

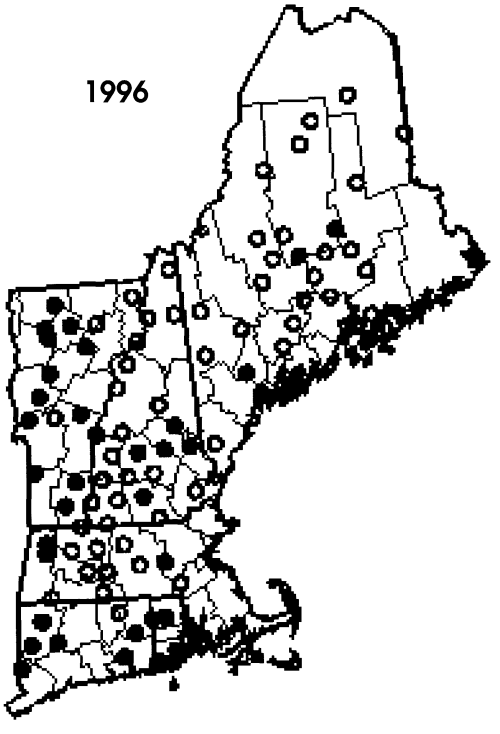
1994



1995



1996



III. What about specific problems and pests?

The overview

As we monitor conditions in the forest, we frequently encounter special problems caused by various stress factors. Common stress factors may be living organisms, such as insects, deer, or disease organisms. There are also many common stress factors that are nonliving such as fire, wind, drought, and pollution.

Sometimes damage from a given stress factor is very prevalent in a certain county, state, or region. When this is the case, surveys of the presence, activity, and biological consequences are conducted through a joint program between the federal government and the state(s) where damage is occurring. This program is known as the Cooperative Forest Health Protection Program. With the information collected in the forest-wide surveys made under this program, maps and reports are developed on an annual basis to inform land managers and others about the problems occurring in the forest.

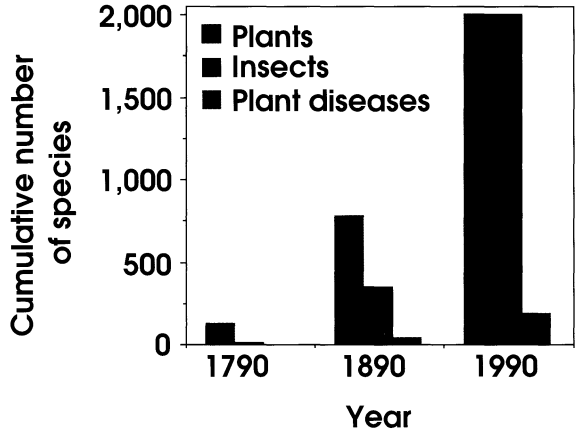
On the following pages, you will find some basic information about various living and nonliving stress factors that have recently been of major importance in the New England & New York Region.

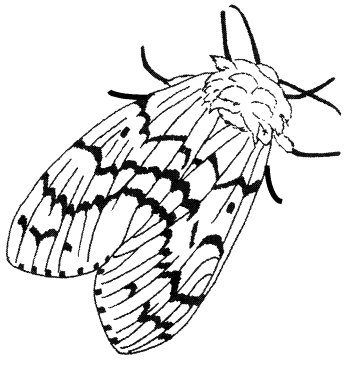
Exotic species

Sometimes an organism is found outside of its natural range. When organisms are found living in parts of the world where they are not native, these organisms are referred to as "exotic species" in that new location. Most organisms that reach new locations as exotics are transported to those locations by human activity. Many times, humans purposefully bring new species into an area. Other times, people move organisms about without really knowing it--for example, organisms may "hitch rides" on cars or ships or they may be found in fruits or wood or other cargo that is moved from one location to another.

It is estimated that at least 4,500 exotic species are now established in the United States. Many of these are very beneficial. Examples include most crop plants and domesticated animals that we raise, many types of sport fish, and many organisms that are natural enemies of important insect pests. However, exotic species also can be very harmful. They can become serious pests in the new areas where they have no natural enemies and plants have not developed resistance to the exotics. They may cause decline of native species with which they compete, alter structure and functioning of ecosystems, and lead to serious health concerns and economic loss for humans. The cumulative estimated loss due to selected harmful exotic insects in the United States from 1906-1991 was close to $93 billion.

Estimated cumulative numbers of exotic species in the United States





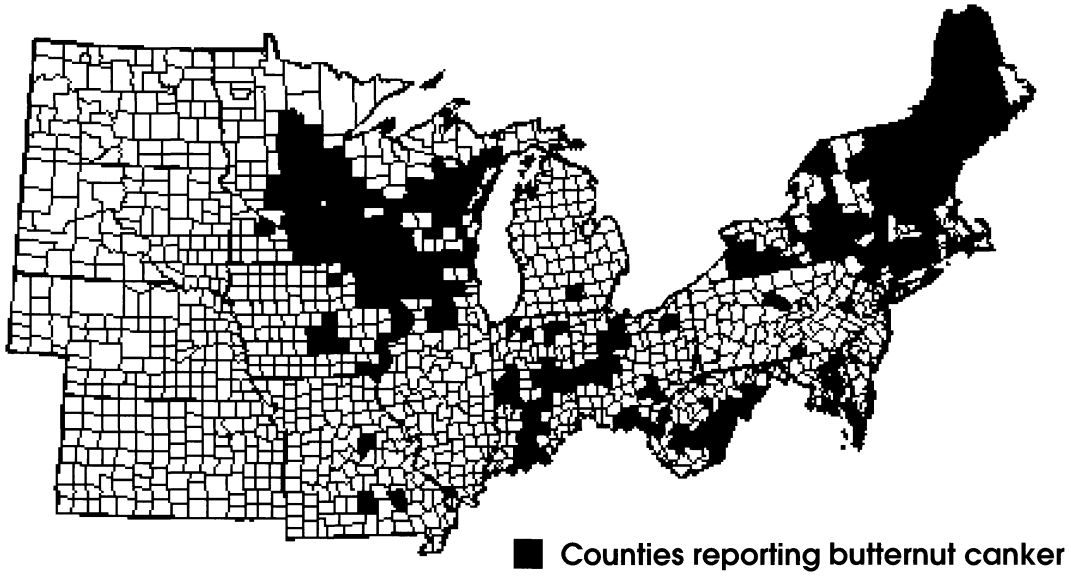
In American forests, exotic insects and disease organisms have been major pests and have caused much tree injury and death. Examples of important introduced pest species include chestnut blight, Dutch elm disease, white pine blister rust, Asian longhorned beetle, common pine shoot beetle, pear thrips, and European gypsy moth. Exotic plant species such as honeysuckle, buckthorn, and purple loosestrife may compete with native plant species in American ecosystems. On the other hand, a variety of exotic species have been purposefully and successfully introduced to act as natural enemies of important forest pests and have greatly aided in control of these pests.

Butternut canker

Butternut canker is a fungal disease of butternut trees. We do not know whether this fungus is native or introduced or how long it has been in North America. Although first detected in Wisconsin in 1967, it was probably present much earlier.

Butternut trees are infected through buds, leaf scars, and possibly through insect wounds or other openings in the bark. When a tree is infected with this disease, patches of bark are killed. These dead areas, called cankers, can eventually encircle branches and stems and cut off the flow of water and food within the tree. This is called *girdling.* Reproductive structures of the fungus form in the cankers and are spread down the tree by rain water. As the number of infected sites on the tree increases, dieback in the crown accelerates. Heavily infected trees are killed.

Butternut is a relatively minor component of forests in the eastern United States. The nuts, when present, are an important food source for some types of wildlife, and quality butternut wood currently ranks among the highest in value of all hardwood trees. Butternut also is important as a part of biological diversity in our forest. The map below shows areas of the forest where surveys have confirmed that butternut canker is present:

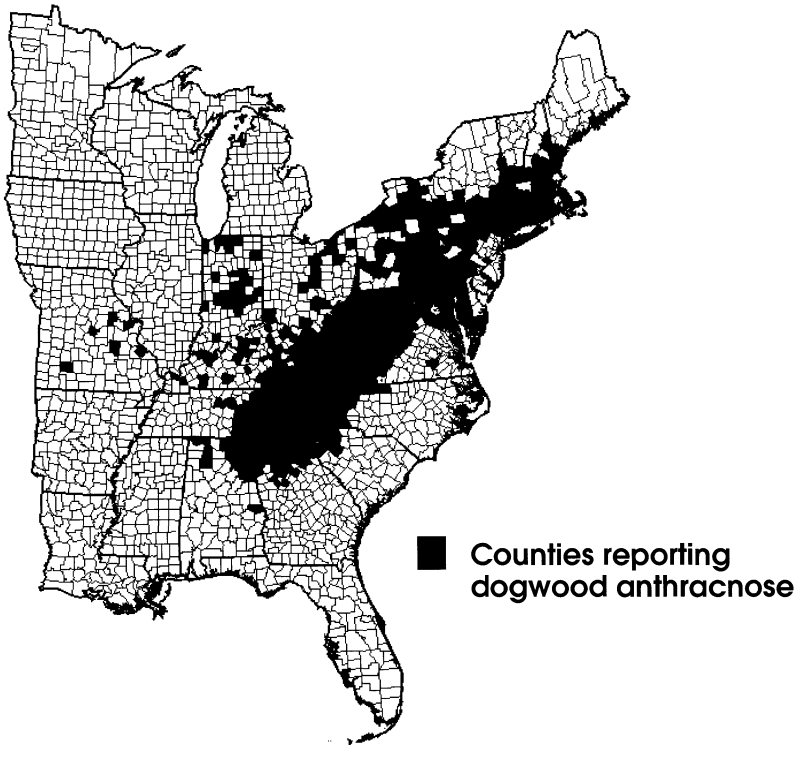


During the past 10 to 15 years, butternut canker has contributed to a dramatic decrease in the number of live butternut trees found in the United States. The decrease has been as much as 80% in some states. Management strategies for butternut canker in the eastern United States include monitoring efforts to assess the general health of butternut trees, conservation of certain individual butternut trees that may have resistance to this disease, and efforts to breed resistant strains of butternut.

Dogwood anthracnose

The flowering dogwood is a common native understory tree in many hardwood forests. It is often found associated with maple-beech-birch, oak-hickory, and oak-pine forest types. The flowering dogwood is an extremely important ornamental tree in the eastern United States.

A common fungal disease of flowering dogwood is dogwood anthracnose. This disease occurs in 23 eastern states and has spread to the northern limit of the native range for flowering dogwood. The distribution of this disease in 1996 is shown below:



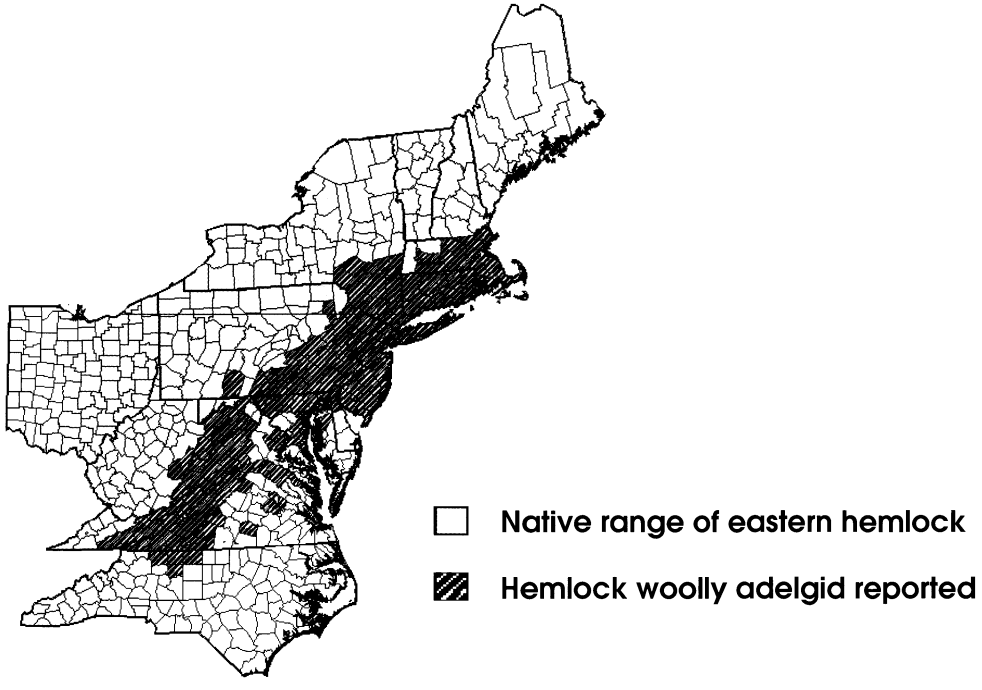
Dogwood anthracnose was first reported in New York in the mid-1970's. The origin of this disease is unknown, but it is probably not native to North America. Dogwoods of all sizes and ages are attacked. The fungus that causes dogwood anthracnose prefers cool, moist conditions. Dogwoods in rural forests, at higher elevations, and along waterways are most susceptible. Dogwoods in well-maintained landscape settings are less affected.

Dogwood anthracnose first attacks the leaves and twigs in the tree's lower crown. During spring and early summer, the injured leaves have tan spots with purple rims. Twig dieback occurs next, along with the development of cankers on the twigs, branches, or trunk of the tree. Dogwood trees often die two to five years after being attacked by the fungus. Mortality has been very extensive in some southern states where more than 80% of dogwood stems have died of this disease.

Common management actions include keeping trees well watered and fertilized, preventing mechanical damage, pruning out infected portions of the tree, and raking fallen leaves to remove sources of future infection.

Hemlock woolly adelgid

The hemlock woolly adelgid is a small aphid-like insect that sucks sap from eastern hemlock and Carolina hemlock. This exotic insect pest is native to Asia, but has been in the United States since 1924. The map below shows areas of the forest that have been affected by this insect:



The adult hemlock woolly adelgid is very tiny, about the size of a period on this printed page. However, it is easily recognized during most of the year by white, cottony material that it produces to serve as a protective covering. This cottony material can be seen on young hemlock twigs at the base of the needles.

By sucking sap from the young twigs, this adelgid slows down tree growth and causes the needles to discolor and drop prematurely. If defoliation continues, dieback of major branches occurs and tree mortality may result. The impact of the hemlock woolly adelgid varies from little damage to widespread tree mortality. In most cases, the damage is somewhere between these two extremes.

Management for hemlock woolly adelgid at this time concentrates on hemlock trees growing in ornamental landscapes and nurseries. Strategies include careful monitoring for presence of insects, mechanically removing adelgids, using horticultural oils or insecticidal soaps to reduce pest populations, encouraging the activity of natural enemies, and keeping trees healthy by watering.

Asian longhorned beetle

A longhorned beetle was discovered in August, 1996, attacking hardwood trees in Amityville and Brooklyn, New York. This exotic insect is native to Japan, Korea, and southern China where it is a major pest of maples, poplars, and willows. These beetles, known as Asian longhorned beetles, most likely were transported to New York City in wooden crates, on pallets, or in large wood blocks used to brace cargo in ships.

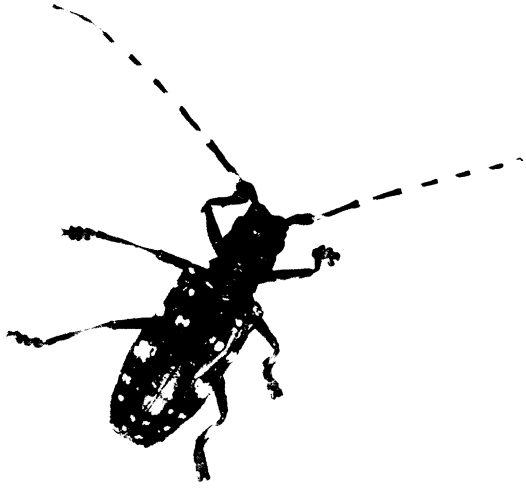
In New York, the beetle has attacked predominantly Norway, red, sugar, and silver maples; boxelder; sycamore; and horsechestnut. It is very important to limit the spread of this insect and to eradicate it if possible since it has the potential to cause serious damage to maple trees and other hardwood species in both urban and rural situations.

The most commonly recognized signs and symptoms of this insect include:

• The adult beetles are 1 to 1.5 inches long and have black bodies with white spots. The antennae are black and white and as long as or longer than the beetle's body (see picture below).

• The insect makes large round holes (1/2 inch diameter) on branches, tree trunks, and exposed roots. These holes are the sites where the beetles exit from the trees.

• Large piles of coarse sawdust are often found around the base of trees or around areas where branches join the main stem. Immature stages of the beetles feed inside trees and the sawdust results when the adult beetles emerge from the trees.



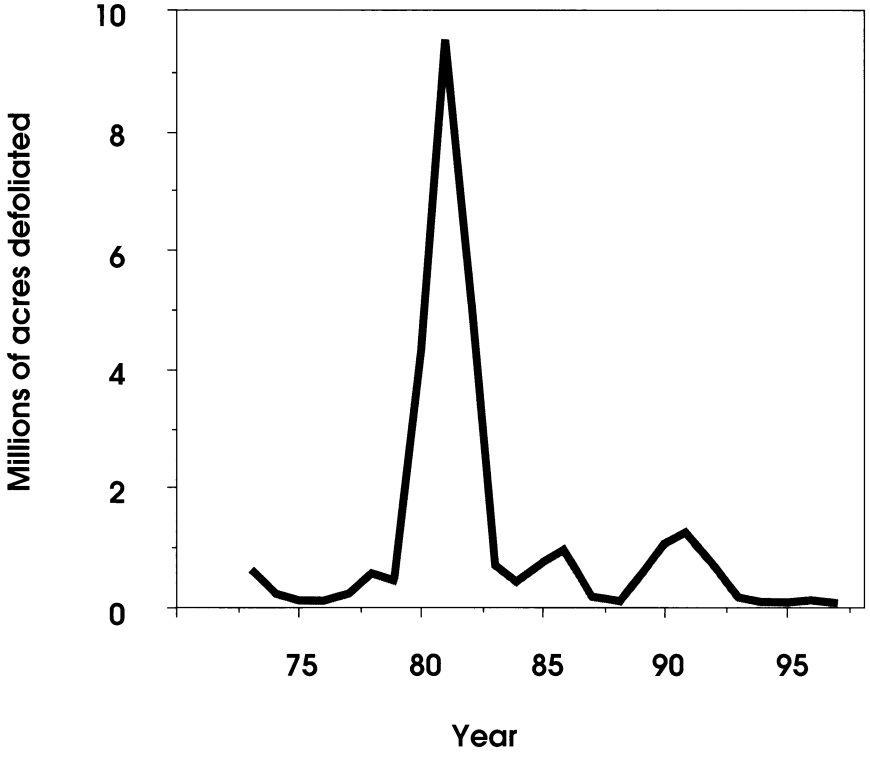
Management activities focus on several areas at this time. The first activity is increased inspection of cargo and associated wood packing material coming from Asian ports. New York and federal quarantines of the infested areas in Amityville and Brooklyn, New York are in force. All infested trees must be destroyed; this involves cutting, chipping, and burning the infested material. Approximately 1,600 infested trees were destroyed during 1997. Efforts are underway to replace the damaged trees.

European gypsy moth

The European gypsy moth, an exotic pest, has been a defoliator of forest, shade, and fruit trees in the New England & New York Region for over 100 years. Gypsy moth larvae feed on hardwood trees, especially oaks, aspens, birches, basswood, witch-hazel, and willows. When populations of gypsy moth are at outbreak levels, the insects may feed on the leaves and needles of most tree species.

Feeding by the gypsy moth reduces the amount of leaf area that trees have available for food production, can lead to reduced tree growth, and may make trees more susceptible to other stress factors such as drought, frost, other insect pests, or diseases. The amount of damage caused by gypsy moth feeding varies depending upon the tree species, presence of other stress factors, and frequency and severity of defoliation. If defoliation is heavy and repeated in rural landscapes, various stress factors can lead to death of weakened trees and changes in the density and composition of forest stands. In suburban and urban areas, the gypsy moth causes aesthetic damage and is a nuisance to people, in addition to leading to reductions in tree vigor.

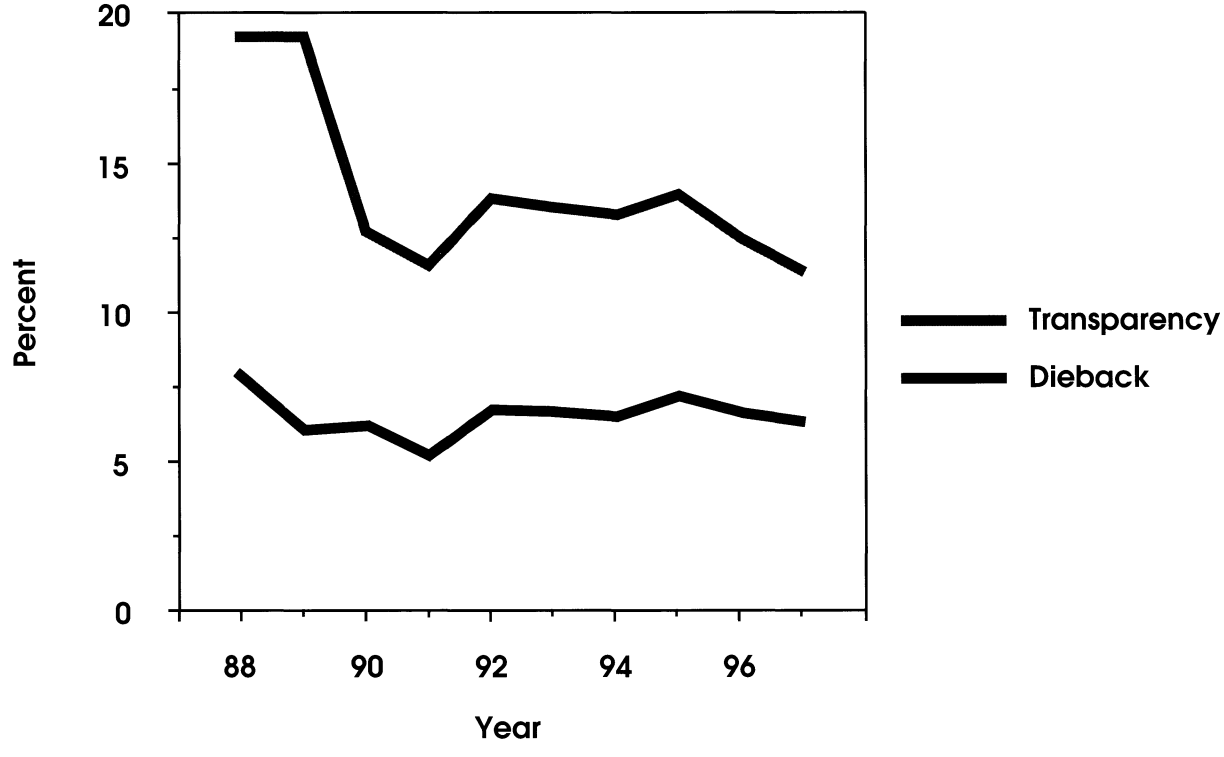
Gypsy moth population numbers and defoliation in the New England & New York Region have decreased by over 99% since 1991. A large amount of this reduction is due to *Entomophaga maimaiga*, a fungus that causes a disease of the gypsy moth. The disease was first observed in New England in 1989. Other factors contributing to the decline include a naturally occurring virus of the gypsy moth (NPV) and sprays of microbial insecticides used for the purpose of reducing nuisance and protecting foliage. The data below shows gypsy moth defoliation in the New England & New York Region for the last 25 years (1973 to 1997):



Management measures for gypsy moth in the New England & New York Region include monitoring to locate infested areas, spraying of generally infested areas to suppress nuisance to people and prevent excessive removal of leaves, applying appropriate management techniques to improve the health of oak stands, and educating the public about the gypsy moth.

Maple stressors

During the late 1970s and throughout the 1980s, maple syrup producers, land managers who managed northern hardwood forests, and the general public became concerned about the health of maple stands in relationship to acid rain and other disturbances. In response to these concerns, the North American Maple Project (NAMP) was formed in 1987 between Canada and the United States. The total number of forest stands monitored and evaluated annually by NAMP is 233. Geographic coverage extends from Minnesota and Ontario, south to Ohio and Pennsylvania, and east to Nova Scotia. Stands were selected to cover the range of major sugar maple growing areas, forest decline conditions, and site conditions. Approximately half of the plot clusters are in active sugarbushes (maple stands used for maple syrup production) and half are in non-sugarbushes. Sugar maple crowns are evaluated annually for dieback and foliage transparency. Results presented below are based on analyses of the crown conditions of over 4,000 mature, live sugar maple trees in the New England & New York Region:



The overall condition of sugar maple trees at the NAMP sites in the New England & New York Region is good. There is no difference in the health of sugar maple in sugarbush and non-sugarbush stands. Both types of management regimes responded similarly to stress. Most improvements in crown condition between 1988 and 1997 are associated with recovery from various types of damage (maple webworm in New York and pear thrips in Vermont and Massachusetts). Although crown conditions improved overall during the last ten years, numerous local disturbances caused by insect defoliators, drought, and wind have led to annual fluctuations in tree conditions in some regions. Mortality of trees in the overstory and understory layers of the forest have averaged 0.9% and 1.9% per year, respectively, since 1989. This annual mortality is within normal variation of stands as they develop and age.

Weather

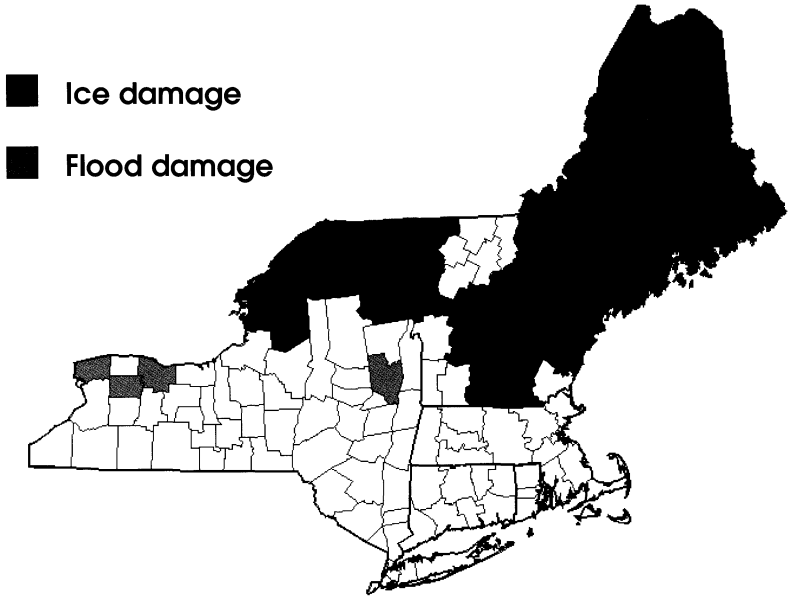
Weather patterns can have both positive and negative effects on forests. Mild weather with good moisture availability helps to promote good tree growth. However, many weather events are less favorable to tree health. The effects of weather-related stress may be mild branch dieback, overall loss of vigor in trees and a general sickly appearance, or even death of trees.

Temperature: Very high or low temperatures can both cause problems for trees. During late winter and early spring, temperatures at the surface of tree bark may fluctuate rapidly from very cold to warm as the bark is heated by the sun. Such temperature changes can promote cracks forming in trees. Tree buds that start to swell and grow early in the spring may also be harmed by sudden spring cold snaps. Frost can damage tender new tree leaves that have recently emerged and not had time to mature.

Moisture: The proper amount of moisture is very important in maintaining a healthy forest. Soils may become saturated in localized low-lying areas after heavy rains. Excess water can be a problem on a widespread basis when rivers flood. Although trees need water to grow, if their roots are submerged during the growing season trees can drown in the excess water and die.

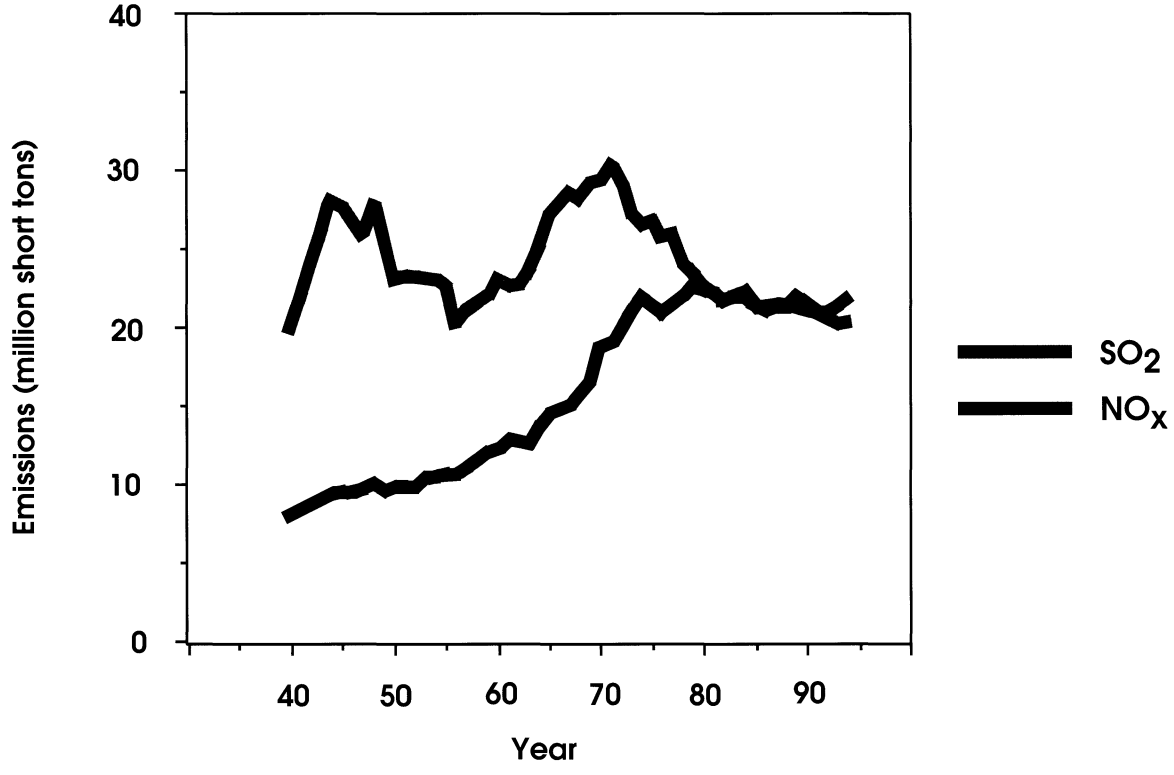
Too little water also is a serious problem for trees. When low precipitation is combined with high temperatures for long time periods, drought stress can be severe. Trees may droop, foliage may look scorched, and trees may experience branch dieback or even death. Significant droughts occurred in this region in 1993 and 1995.

Storms and wind: Strong winds and precipitation that accompany both winter and summer storms can present serious challenges for trees. Branches or portions of trees may be broken off and whole trees may blow over or be uprooted. Storms have been an important forest stress factor in the New England & New York Region. Summer windstorms in the New York Adirondack Mountains uprooted trees across more than one million acres in 1995. In April 1997, a large snowstorm caused tree damage throughout southern New England. Mid-winter storms that lead to the build-up of ice can also cause significant damage to trees. Major ice storms occurred throughout the northern New England & New York Region in January, 1998. These storms caused damage across 17 million acres in four states. The counties designated for Federal Disaster Aid due to ice damage or floods resulting from meltwater are shown in the map below:



Acid rain

A variety of atmospheric pollutants have long been of concern to people. In recent years, there has been a great deal of interest in those atmospheric pollutants that contribute to the formation of acid rain. Key pollutants involved are oxides of nitrogen and sulfur. The emissions of nitrogen oxides and sulfur oxides in the eastern United States have changed dramatically over time:



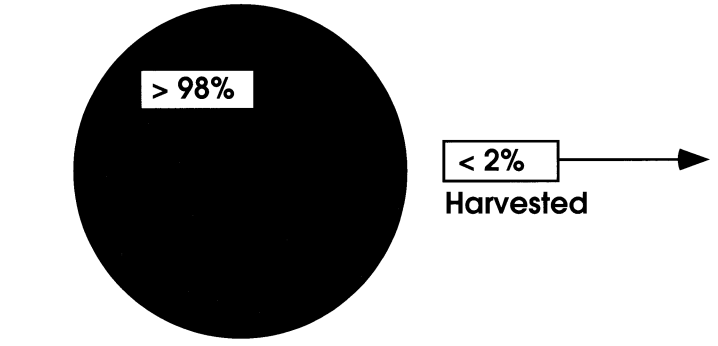
The rates of sulfur and nitrogen oxide emissions generally increased between 1900 and 1970 because of increased coal use, industrialization, emissions from electric power plants, and increased fossil fuel burning for transportation. After the passage of the Clean Air Act in the United States in 1970, emissions controls were put in place which led to decreases in sulfur oxide emissions.

The extent of effects from acid rain is still uncertain, and the matter is under further investigation. There is currently no evidence of a widespread decline in United States forests due to acid rain. However, acid rain is contributing to problems with forest health in certain localized regions where trees are exposed to highly acidic fogs and cloud masses on a frequent basis. There also may be subtle effects of acid rain on retention and cycling of nutrients through the forest and in the forest soils. It is possible as well that growth of young plants may be harmed by acid precipitation, leading to potential difficulties with normal forest regeneration.

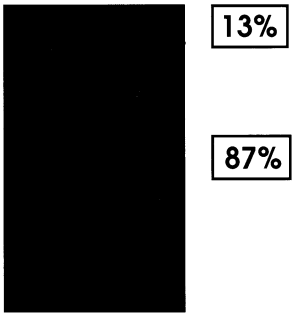
Clearcutting

Clearcutting is a type of tree harvesting in which all trees are removed from an area. In the New England & New York Region, spruce and fir stands are usually harvested by clearcutting. Some people do not like the appearance of clearcuts. However, in the absence of fire, this type of harvesting system and the kind of forest re-growth that it promotes are important to our ability to maintain certain types of wildlife and certain types of shade-intolerant tree species. For instance, grouse, woodcock, and deer thrive in the thick aspen stands that can regenerate in open, sunny, clearcut areas. To increase aesthetic appeal of the landscape, land managers strive to blend clearcuts in with the surroundings as naturally as possible. This is done by carefully regulating the size of the clearcut and by considering the shape of the opening so that the edges are somewhat natural in contour rather than being perfectly straight.

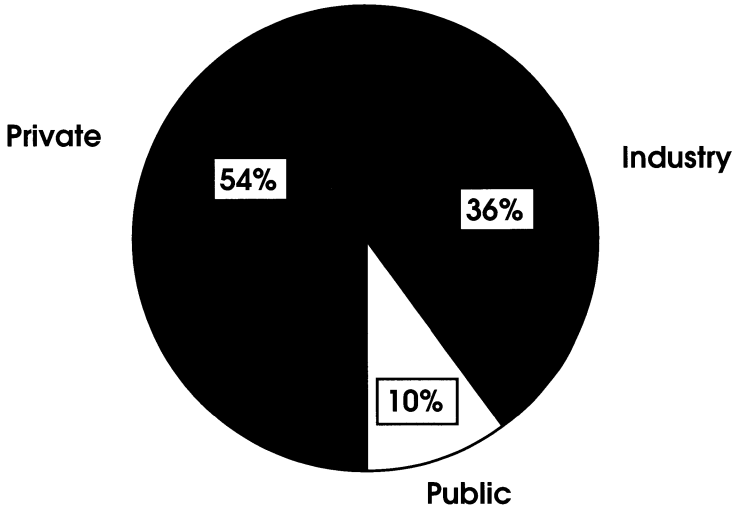
Of the total forested area in the New England & New York and Mid-Atlantic Regions, the estimated portion harvested each year from 1980-1990:



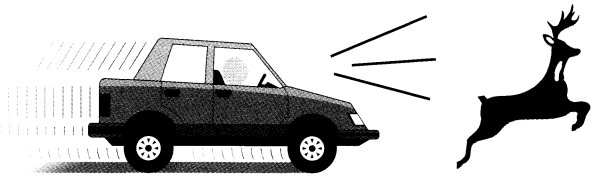
Of the total harvested area (<2%) in the New England & New York and Mid-Atlantic Regions, the estimated portion clearcut and partially cut each year from 1980-1990:



Estimated distribution of clearcutting among land ownership types in the New England & New York and Mid-Atlantic Regions from 1980-1990:

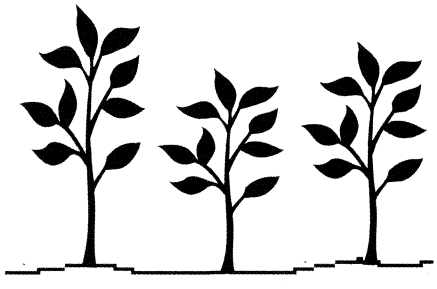


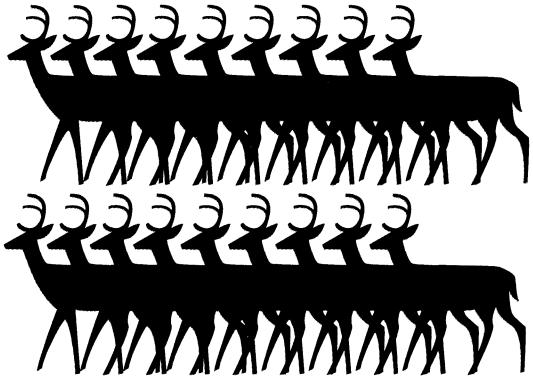
Eastern whitetail deer



Deer/car accidents: The number of deer/car accidents has increased considerably during the past 10 years. Average loss from such accidents in the New England & New York Region is approximately $1,500.

Tree, shrub, and crop damage: Deer feed on trees and shrubs both in rural forests and in suburban communities. Excessive deer browsing in forests can lead to the selective removal of certain species, such as yew, and to difficulties with regeneration of various tree species, such as pines, oaks, and cedars. Often farmfields and gardens are interspersed with forested areas. Deer can cause significant damage by feeding on crop plants in these areas.

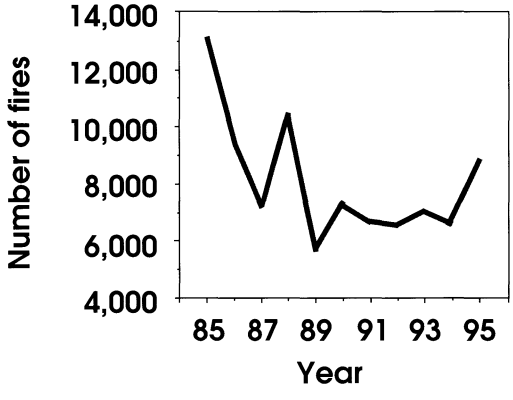


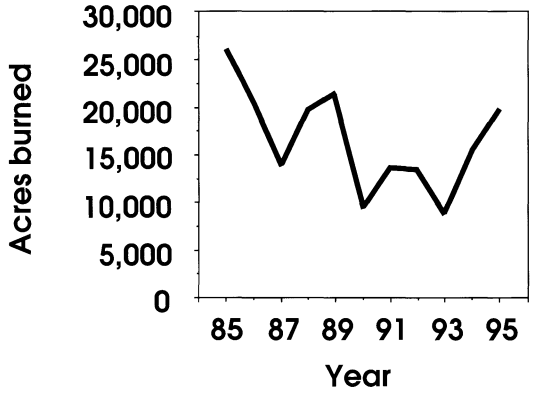


Overpopulation: Deer herds can readily build up to very high numbers. In some cases, this can lead to increased problems for humans because of the corresponding increases in deer/car accidents and plant damage. High deer population levels also lead to problems for the deer. Food can become scarce during harsh winter weather and many deer may starve. Also, parasites and diseases can become problems when deer are very crowded. A few of these diseases, such as bovine tuberculosis and Lyme disease, pose a concern for humans as well.

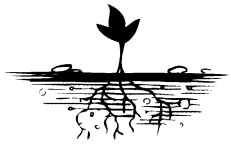
Forest fire

Estimated number of fires and acres burned in the New England & New York Region from 1985-1995:



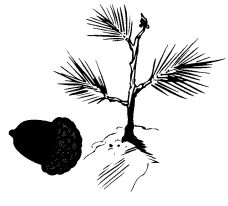


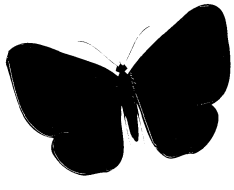
Although fires cost money to control, endanger lives, and damage property, periodic fires have benefits to natural systems:



Fire bares mineral soil. Such bare mineral soil is needed by some plant species for their seeds to germinate. Also, some types of seeds need to be heated to high temperatures in order to sprout. Fires also release nutrients as they burn and this has a fertilization effect, allowing vigorous plant regrowth.

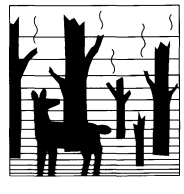
Fire impacts succession and helps to maintain the proper habitat conditions for early successional plant species. Grasses, wildflowers, berry plants like blueberries, and tree species like oaks and pines benefit from periodic fires.





Fire also helps to maintain appropriate habitat for animals associated with the fire-dependent plant species. For example, dozens of rare native butterfly species depend upon wildflowers that appear after wildfire in the pine barrens of Long Island. Also, wildfire in western New York state sustains the habitat needed for the Karner blue butterfly to survive in pitch pine/scrub oak ecosystems.

Most animals can move fairly easily out of an area that is burning and find shelter in the surrounding ecosystems. They often move back into the burned area to feed on the abundant grasses and other plants that spring up soon after a fire.



Periodic fires can be beneficial because they burn up the dead plant material on the forest floor. When fires are prevented and do not occur for long periods of time, the large amounts of fuel accumulated on the forest floor lead to very dangerous conditions. Any fire that accidentally starts will likely be much larger and hotter than would be the case if only low amounts of fuel were present on the forest floor. Therefore, frequent small fires greatly reduce the possibility of large disastrous fires.

IV. Summary

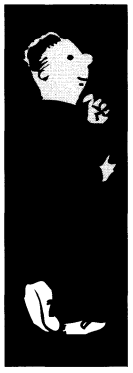
Maintaining healthy forests is very important ecologically, socially, and economically. We rely on forests to protect our air, water, and soil resources. Forests provide us with diversity in habitats and wildlife, and at the same time serve as important sources of timber. We turn to forests for aesthetic and recreational uses. Forests greatly affect our economy as well. They provide hundreds of thousands of jobs both directly and indirectly linked to the forest, its plant and animal products, and tourism in forest areas. More and more, people are coming to realize the great value that forests have for us and the important role that forests and their products play in our lives. With this realization comes an interest in forest health and in utilizing our forest resources wisely so that healthy forests will continue to be available for future generations.

Despite the increased interest in forest health and its obvious importance, the concept of a healthy forest has not been easy to define. It is a concept that involves not only scientific data but also a consideration of uses for forest areas, perceptions of various user groups and interested parties, judgement calls regarding the importance of various factors, and personal standards of what is appropriate and desirable in our natural world.

The Forest Health Monitoring Program is headed by the USDA Forest Service and carried out in cooperation with a variety of federal and state agencies and universities. It has been a major forest health monitoring and research initiative aimed at collecting scientific data on tree conditions and factors that damage trees. Extensive study of trees, insects, diseases, pollutants, and related factors has been carried out in permanent plots and other forest areas under this program.

In general, trees are in good condition throughout the forests of the New England & New York Region. On average, trees of most species score very well in terms of a number of variables that measure condition of the tree crown. Trees in this region also generally have little damage to their trunks. Some tree species and forest stands in certain areas are in poorer condition, and this is traceable to a variety of stress factors. A number of insects and diseases have stressed New England & New York forests to various extents. The most severe effects occur when the impacts of these organisms are combined with adverse weather conditions or other stresses such as pollutants or large forest fires. Stress also is often more severe when the organisms involved are not native, but are instead exotic species that have been imported from other parts of the world.

The Forest Health Monitoring Program, in combination with other research efforts, is helping us better understand the frequency, distribution, and effects of forest stress factors and provides us with a picture of current tree conditions in our forests. By continuing such monitoring programs and other research efforts, we will be well equipped to identify changes that occur in forest conditions and to recognize and track long-term trends. With this information, we will be even better able to manage our forests and keep our forests healthy.



Want to know more?

USDA Forest Service
State & Private Forestry--Field Office
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